Cyber Selection Test Research Effort for U.S. Army New Accessions

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Purpose

Army Need: To identify initial entry personnel who have the potential for high performance in the Cyberspace Workforce

Objective: Develop and refine selection measures for new accessions to more fully assess an individual's potential and more accurately predict performance, behavior, and attitudes.

Efforts: Four research efforts benefitting the selection and classification of new accessions for cyber occupations will be discussed:

- Cyber Test Validation Research for the Joint Cyber Analysis Course
- Cyber Test Validation Research within a sample of Information Technology Specialists
- Common Cyber Capabilities Test
- Systems Thinking Ability Test

Cyber Test (CT)

Army Need: To identify initial entry and in-service personnel who have the potential for high performance in the Cyberspace Workforce

In **2006 an ASVAB review panel provided recommendations for enhancing the ASVAB:** *"…research should be conducted to develop and evaluate a test of information and communications technology literacy."*

In **2008** the Air Force developed the CT test with consultation from SMEs from all U.S. services

Cyber Test (CT) – formerly known as iCTL

IT Software/Tools and PC Configuration/Maint. (36%)	Networking and Communications (27%)
What kind of software (spreadsheet/word processing) is appropriate for a specified task?	• *What are IP addresses? What are network protocols?*
Security and Compliance (23%)	**Software Programming and Web Development (14%)**
What are viruses? What are security concerns with the Internet?	• *What are differences between different data formats?*

Overview of the Cyber Test:
- 29 multiple choice items.
- 15-20 minutes to complete the test.
- Two different test forms currently in use.
- The CT is a special test that applicants take.

- Future joint service research may develop a computerized adaptive test version of the CT.
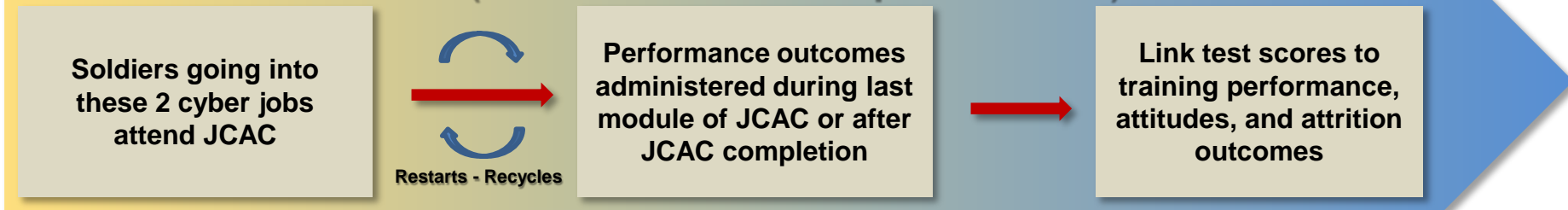
Joint Cyber Analysis Course (JCAC) Cyber Test Validation Research

Operational use of CT & ASVAB–Skilled Technical (ST) for two cyber jobs:
- Administered CT operationally since 2 June 2014
- Required minimum ST of 112 and CT of 60

Validation Procedure: (Administered via Paper & Pencil)

Soldiers going into these 2 cyber jobs attend JCAC

Restarts - Recycles

→

Performance outcomes administered during last module of JCAC or after JCAC completion

→

Link test scores to training performance, attitudes, and attrition outcomes

Measures for Validation

Tests:
- **ICTL / Cyber Test**
- **ASVAB – Skilled Technical**

Outcomes:
- **JCAC grades**
- **Performance rating scales**
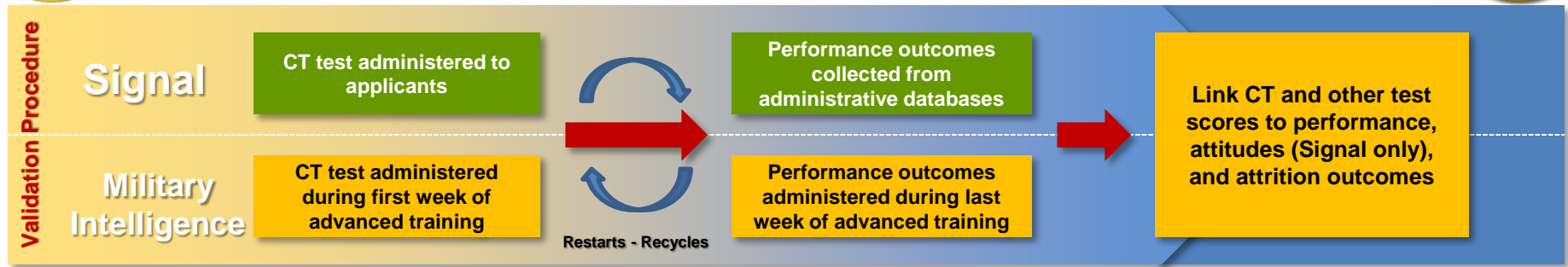- **Job knowledge test**
- **Attitudes**
- **Attrition**

Data Collection Update:

Males: 87
Females: 10
Total: 97

Note: ARI has recently developed two in-service versions of the CT that are parallel to the CT used for applicants.

Past Cyber Test Validation Research

Validation Procedure

Signal

| CT test administered to applicants | | Performance outcomes collected from administrative databases |

Military Intelligence

| CT test administered during first week of advanced training | | Performance outcomes administered during last week of advanced training |

Restarts - Recycles

Link CT and other test scores to performance, attitudes (Signal only), and attrition outcomes

*Outcomes of Interest

Attrition: Administrative data extracted from personnel database

Training Failure/Restarts: Administrative data extracted from Training System

AIT Course Grade Average: Administrative data extracted from Training System

Job Fit (Signal only): Measures the Soldier's perceived fit with their job

Peer Rated Training Performance (Signal only): Evaluates Soldier performance across a number of identified job-specific performance domains. Developed with SMEs in respective jobs.

Training Performance Domains
Learns to implement a network
Learns hardware concepts
Learns to administer software applications
Learns the fundamentals of network security
Learns basics of troubleshooting
Learns safety procedures

* Significant positive relationships were found between the CT scores and these outcome variables within a sample of Information Technology Specialists.
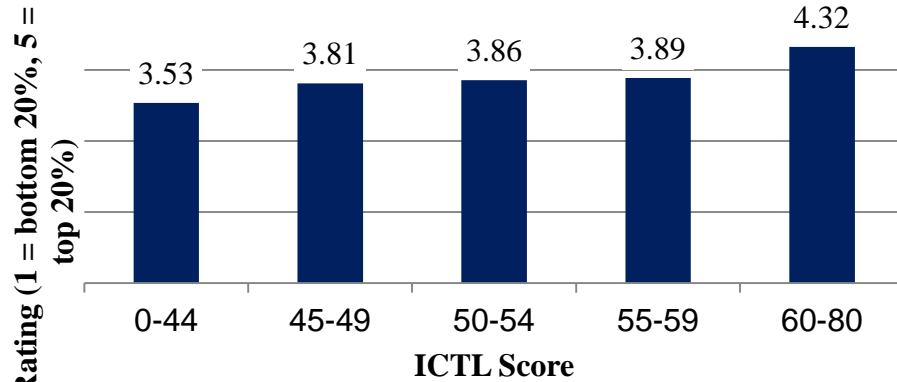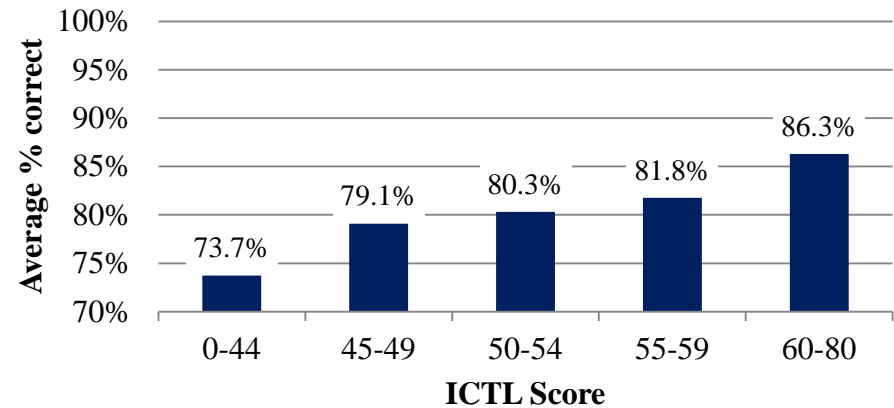
Performance Rating Scale Mean
N = 2,139, r = .327

Rating (1 = bottom 20%, 5 = top 20%)

ICTL Score	Rating
0-44	3.53
45-49	3.81
50-54	3.86
55-59	3.89
60-80	4.32

Advanced Individual Training Final Course Grade
N = 1,805, r = .405

Average % correct

ICTL Score	Average % correct
0-44	73.7%
45-49	79.1%
50-54	80.3%
55-59	81.8%
60-80	86.3%

Graduate Advanced Individual Training without Failure
N = 1,435, r = .158

% with at least 1 Restart

ICTL Score	% with at least 1 Restart
0-44	69.8%
45-49	79.9%
50-54	86.7%
55-59	90.5%
60-80	89.9%
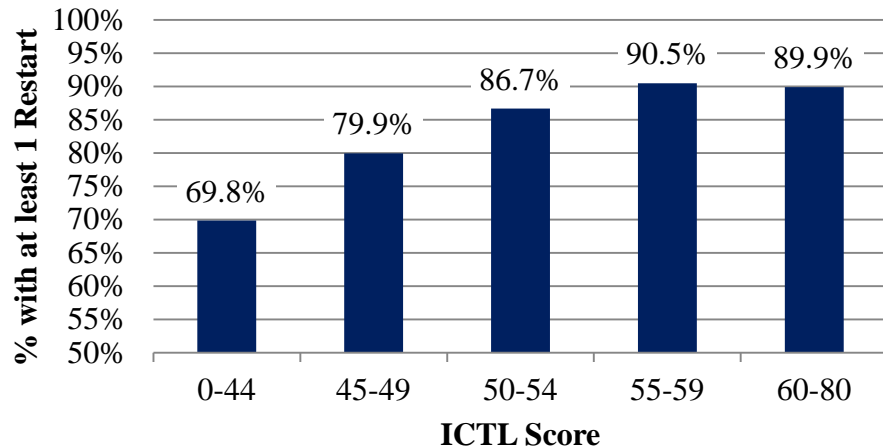
End Of Training Warrior Tasks and Battle Drill Job Knowledge Test
N = 959, r = .357

% correct

ICTL Score	% correct
0-44	56.0%
45-49	55.7%
50-54	58.8%
55-59	61.3%
60-80	66.7%
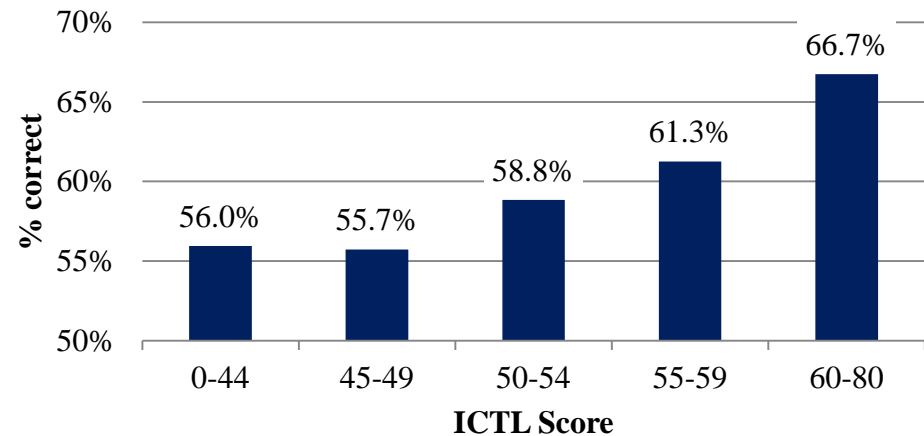
Knowledge-based Measures

Pros	Cons
• High fidelity to cyber realm	• Technology changes quickly; content becomes obsolete
• Identifies a pre-existing interest in cyber / drawn to engage with cyber	• As a result, knowledge-based measures require more cost and effort to maintain over time
• Straightforward to create & interpret	
• Adds additional predictability above and beyond the ASVAB, especially in high ability populations	• Might miss high-potential applicants without prior technology exposure
• Preliminary evidence suggests that the CT has lower adverse impact than most ASVAB sub-tests	• Exposure of items over time may increase the risk of compromising item integrity

Two projects are underway to examine alternatives to knowledge-based tests:
1. Common Cyber Capabilities Test
2. Systems Thinking Assessment

Common Cyber Capabilities Test (C^3)

Common Cyber Capabilities Test – Assessment of the skills, abilities, and other characteristics that are most predictive of trainability and success across the Army's various cyber jobs. C^3 will be a computer-administered self-scoring test of skills and abilities that are not covered by established Army measures.

Research Plan

ONGOING

1. Review literature

2. Jobs Analyses

PLANNED

3. Develop measures of selected capabilities

4. Conduct validation of items and scales

5. Combine developed and validated measures into one cohesive product

6. Validate to Army cyber populations

For each cyber job we will:

1. Solicit assistance from potential sponsors

2. Review available task and knowledge/skills/abilities lists

3. Meet with Subject Matter Experts to identify capabilities needed in their jobs

4. Meet with course instructors to identify which capabilities best predict trainability

5. Solicit leadership's feedback on lists yielded by steps 2-4

Lists for each job will be combined to select the 5 to 7 capabilities that will be measured by the C^3

Systems Thinking Assessment

Systems: Dynamic sets of interconnected elements organized in a coherent way that achieve a function or purpose

Systems Thinking: Understanding activity and changing characteristics of a system as it operates and the ability to anticipate effects of actions upon the system to attain particular outcome
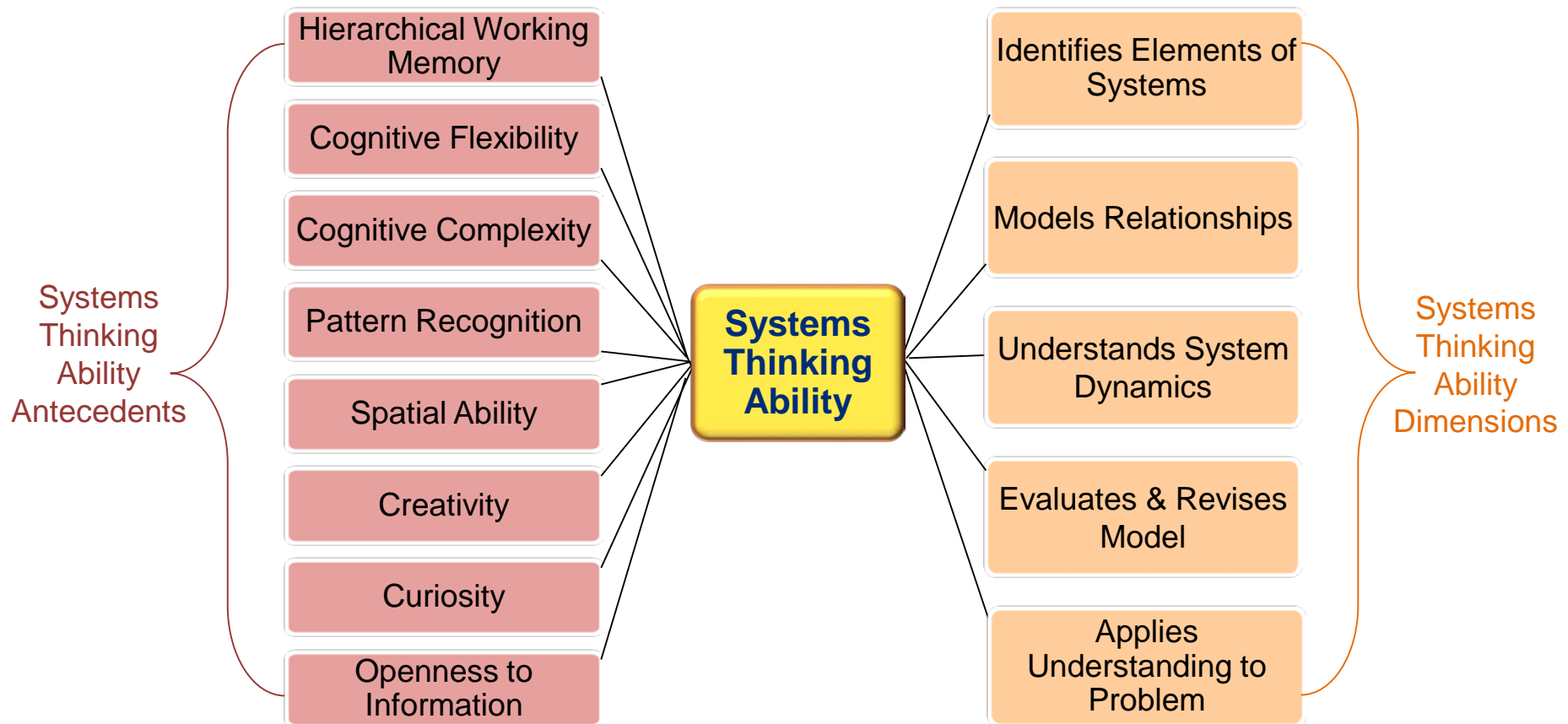
Systems Thinking Ability Antecedents

- Hierarchical Working Memory
- Cognitive Flexibility
- Cognitive Complexity
- Pattern Recognition
- Spatial Ability
- Creativity
- Curiosity
- Openness to Information

Systems Thinking Ability

Systems Thinking Ability Dimensions

- Identifies Elements of Systems
- Models Relationships
- Understands System Dynamics
- Evaluates & Revises Model
- Applies Understanding to Problem

Figure. Preliminary Model of Systems Thinking Ability

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Systems Thinking Ability Test (STA)

ARI has been researching a distinct approach to:

- Identify component capabilities and model of systems thinking ability
- Develop and validate measures of component capabilities
    - Will look to solicit SME feedback on initial measures
- Lay-out how measures could be combined into one cohesive computer-based instrument of systems thinking

Research Plan

COMPLETED

1. Develop and validate assessments for five STA-related abilities

2. Develop the conceptual design and proof-of-concept for a systems thinking assessment game

Working Memory Capacity
Spatial Abilities
Pattern Recognition
Cognitive Complexity
Cognitive Flexibility

PLANNED

3. Develop an operational version of the STA game which incorporates assessments from phase 1 and (through game-play) examines:
    - 3 more STA abilities
    - 5 STA behaviors

4. Validate the system thinking assessment game in an operational setting

Creativity
Curiosity
Openness to Information

Identifies Elements of Systems
Models Relationships
Understands System Dynamics
Evaluates & Revises Model
Applies Understanding to Problem

STA Game Mockup
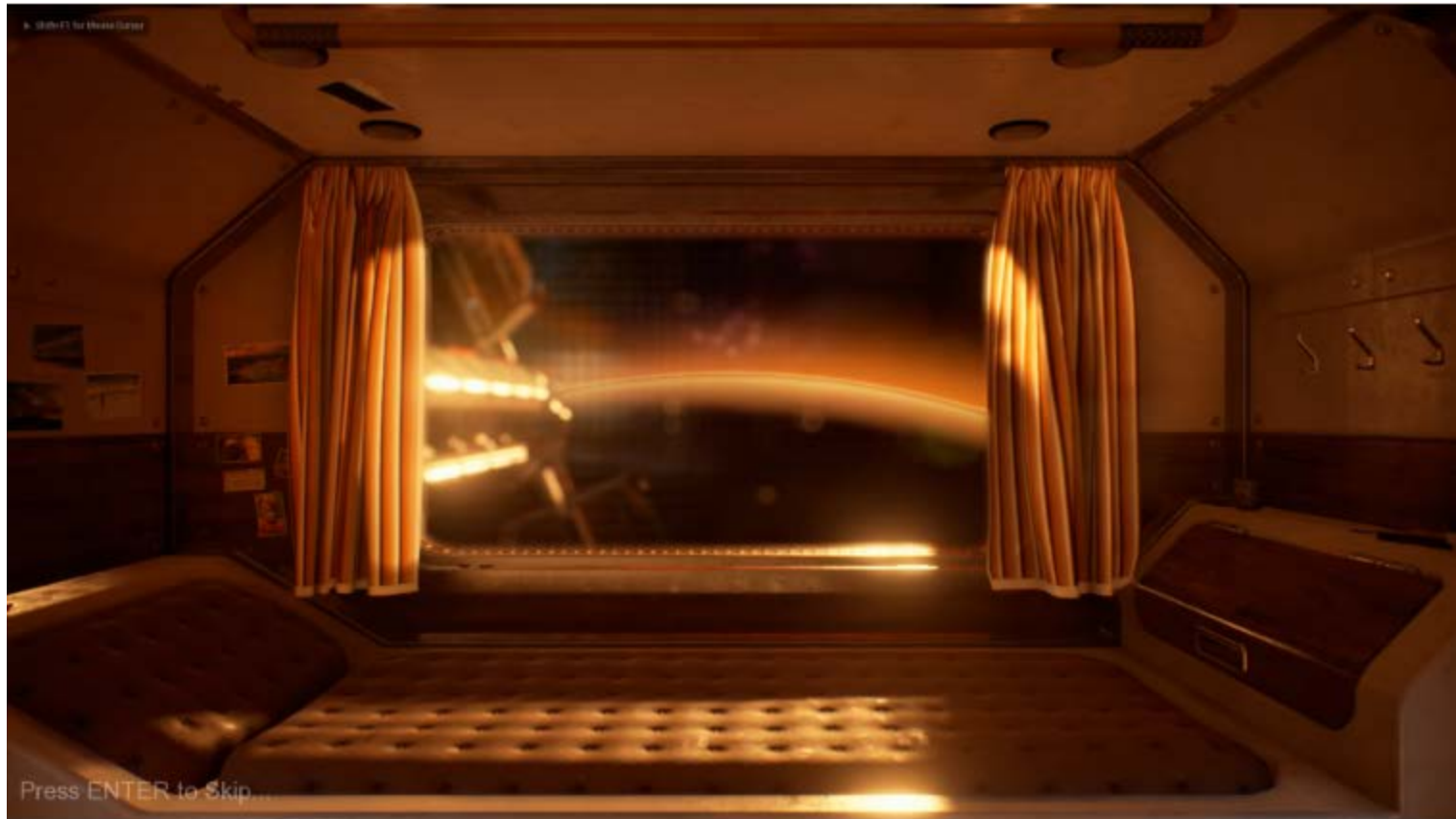
Summary

- Identifying talent among the Army's new accessions remains a priority for the Army's cyber occupations.

- The Cyber Test has been a helpful solution based on the research conducted to date.

  - There is the possibility that if the Army continues to use the Cyber Test, ARI may eventually invest in a computerized adaptive test solution to enhance test security.

- Benefits of selection tools for initial entry personnel selection:
  - Increased personnel performance
  - Increased personnel attitudes (e.g., adjustment, satisfaction)
  - Increased match between individual characteristics and job requirements
  - Reduced attrition

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14. ABSTRACT

This paper focuses on the test development and validation efforts for the Army's cyber selection/classification research for new accessions. Four research efforts will be discussed – two validation efforts and the development of two new measures of cyber aptitude. The Army validated the use of the Cyber Test (a joint service, knowledge-based cyber assessment) for two cyber occupations using a variety of outcomes (e.g., peer ratings, attitude measures, job knowledge test, and training grades) and found evidence of validity for classification purposes. Similarly, the Cyber Test is also currently being validated for use with two other entry level cyber occupations. Use of knowledge-based tests has both benefits and disadvantages, which will be discussed. At the same time, the Army is also planning to develop two aptitude measures that are independent of knowledge. One of these, the Common Cyber Capability (CCC) Test, involves assessing which skills and abilities are common across all or most of the Army's Cyber jobs and building an assessment that measures the top 5-7 most common skills and abilities. The CCC is domain dependent and is being designed with input from the SMEs from the Army's major cyber jobs. Another aptitude measure that is being developed is the Systems Thinking (ST) test. This will be a computer simulation, which involves a combination of behavioral and self-response measures of the major systems thinking dimensions. The ST test can be used for classification in a wide variety of jobs in addition to cyber where ST is important.

15. SUBJECT TERMS
Cyber test, cybersecurity, classification and selection, systems thinking, validation research, knowledge tests, aptitude

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